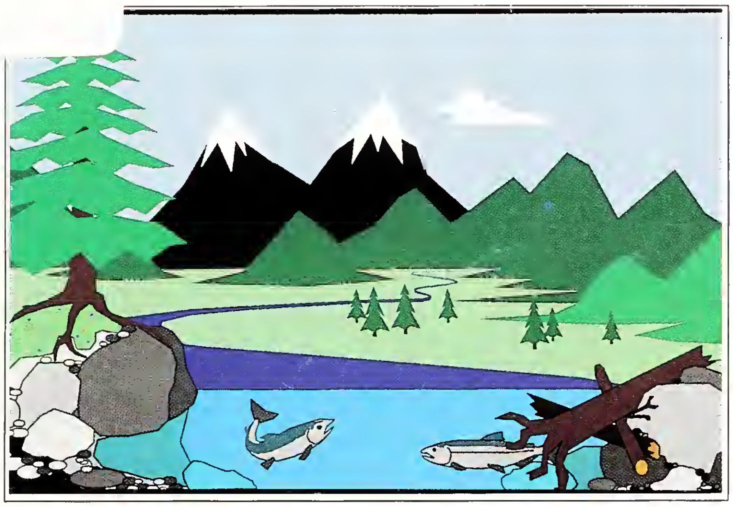

FHR CURRENTS...

R-5's FISH HABITAT RELATIONSHIPS TECHNICAL BULLETIN

NUMBER ONE

FHR Currents . . . Purpose

The Fish Habitat Relationships (FHR) Program of R-5 USFS has been established to research and develop information on fish ecology and to coordinate effective applications of this knowledge in managing and protecting our fisheries. By relating life stage requirements of specific species to physical habitat parameters, we are aiming at our main objective: developing a methodology to manage fisheries through the management of habitat.

Stream Habitat Classification and Inventory Procedures for Northern California

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Introduction

The objective of this bulletin is to describe a stream habitat inventory procedure that will classify and quantify fish habitat in terms of channel features. The procedure is based on information gathered in gravel and boulder-bed streams in the western Cascade Mountains of Oregon and Washington and in the Klamath Mountains of California (Bisson et al., 1981; Sullivan, 1986; Grant et al., in review; Decker et al., in progress). A stream habitat inventory as outlined here can give information on the sequence, distribution, and availability of pool, riffle and run habitat units, and yields a graphic picture of the stream channel (Figure 1). Areas which may be limited in terms of specific habitat (spawning, rearing, etc.) can be identified.

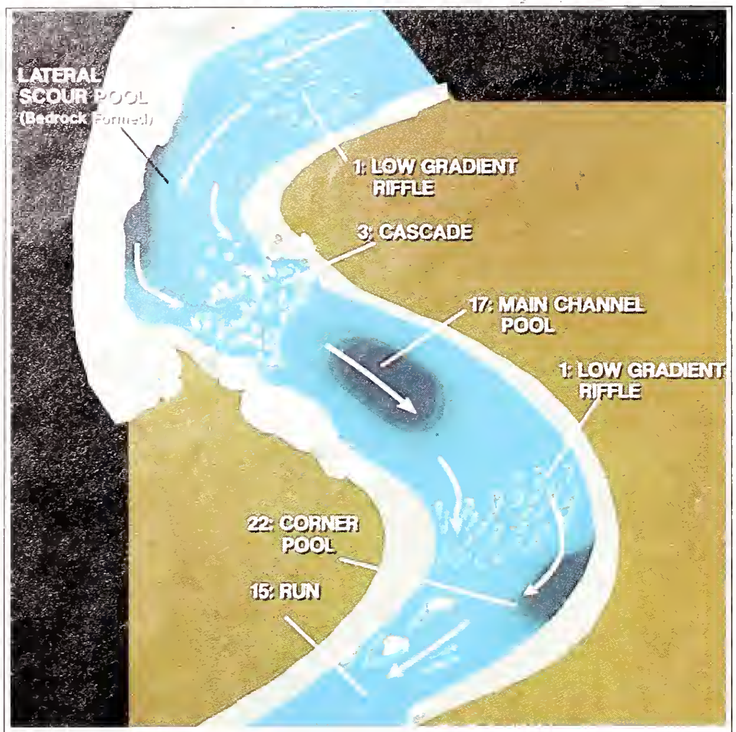


Figure 1. Illustrated above are habitat types in association with channel features such as: logs, boulders, gradient, bedrock and meanders.

Present day fishery management is very complex, involving several different agencies, user groups and land managers. While millions of dollars are being spent annually to restore and enhance anadromous fisheries, man's effect on stream habitat is increasing through the ever growing demands on timber, water, and other resources. A key to effectively protecting, maintaining, restoring, and enhancing anadromous fisheries in light of these demands is an understanding of the relationships between physical habitat parameters (e.g. channel morphology) and fish production factors (food and habitat requirements) for all age classes of each species for the duration of stream residency. Habitat requirements of anadromous salmonids rearing in streams are known to differ between species, age classes, and seasons (Everest and Chapman, 1972; Reiser and Bjornn, 1979).

Because of the diversity in management groups, several different habitat survey or assessment techniques are employed in northern California. This lack of standardization complicates the comparison of information between agencies and often creates barriers in developing and implementing efficient management strategies. This bulletin outlines a standardized habitat assessment procedure with built in flexibility to be workable with varying budgets and manpower.

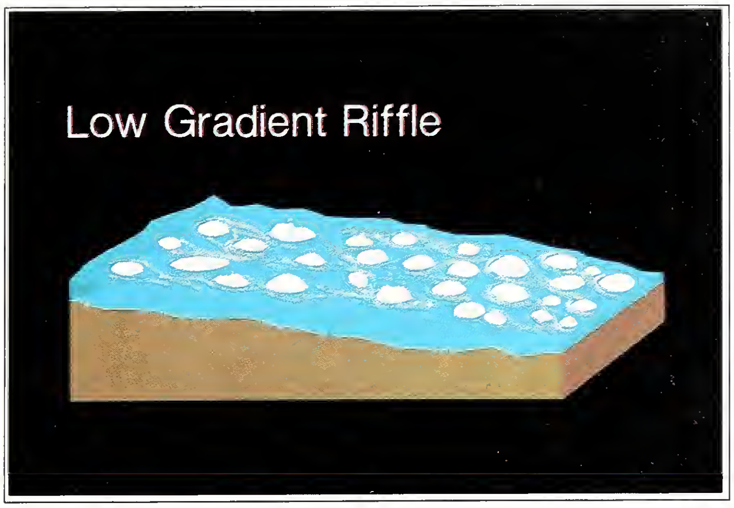
Background

This system of naming habitat is derived from work on stream channel morphology, pool-riffle and step-pool formation, and fish habitat utilization in western Washington and Oregon (Bisson et al., 1981; Sullivan, 1986; Grant et al., in review). The development of pool-riffle or step-pool sequences is a fundamental stream channel process (Ying 1971). These main channel features, along with others formed by smaller scale local effects (e.g. logjams and slides), can be recognized as distinct channel units or habitat types. A total of 22 habitat types have been identified and delineated in northern California to date as the refinement of the system continues *(figure 2, following pages).*

Figure 3 illustrates how the 22 types are classified. Three categories (proceeding from shallow to deep water) are riffles, runs and pools. All of the 22 types are members of the 3 main categories. Riffles are differentiated on the basis of water surface gradient. Pools are differentiated at two levels: (1) the position of the pool in the stream channel (secondary channel, backwater, lateral, or main channel), and then (2) the cause of the scour (obstruction, blockage, constriction, or merging flows). Run habitat types have low gradients, and are differentiated on the basis of depth and velocity. The five-pointed star plots of each type in *Table 1* illustrate the ratio of five physical habitat variables (mean depth, width, and length, and area and volume) for Hurdygurdy Creek, California. The pattern of the starplot describes the "mean shape" of the habitat types. Types with similar star plots have similar morphometry.

Generally, a given stream won't contain all 22 habitat types, instead the mix will be dominated by a few habitat types which are reflective of the overall channel gradient, flow regime, cross-sectional profile, and substrate particle size. (Grant et al. in review) found that the mix of habitat types in western Cascade streams with gradients in excess of 2% and large boulder substrate consisted of 4 types: pool, riffle, rapid, and cascade. Bisson et al. (1981) recognized 14 distinct habitat types in small streams with gradients less than 2%. Basins that exhibit a wide range in channel gradient will also have a

Figure 2. List of 22 habitat types in Northern California.

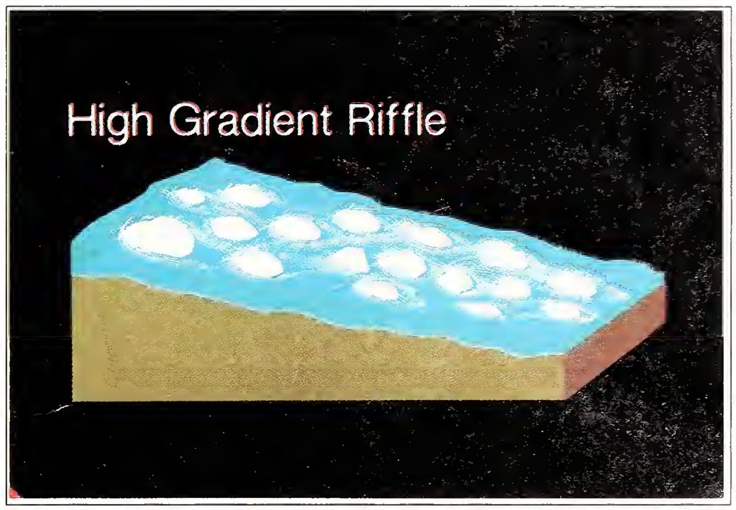


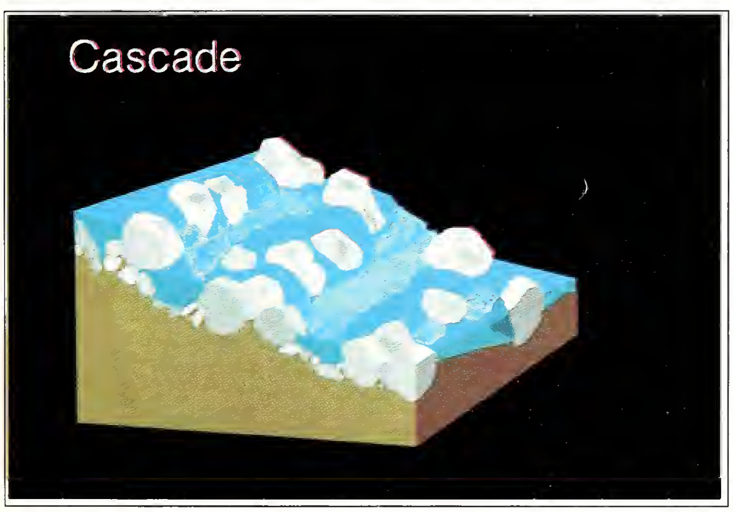
1 — Low Gradient Riffles "LGR"

Shallow reaches with swiftly flowing, turbulent water with some partially exposed substrate. Gradient < 4%, substrate is usually cobble dominated.

2 — High Gradient Riffles "HGR"

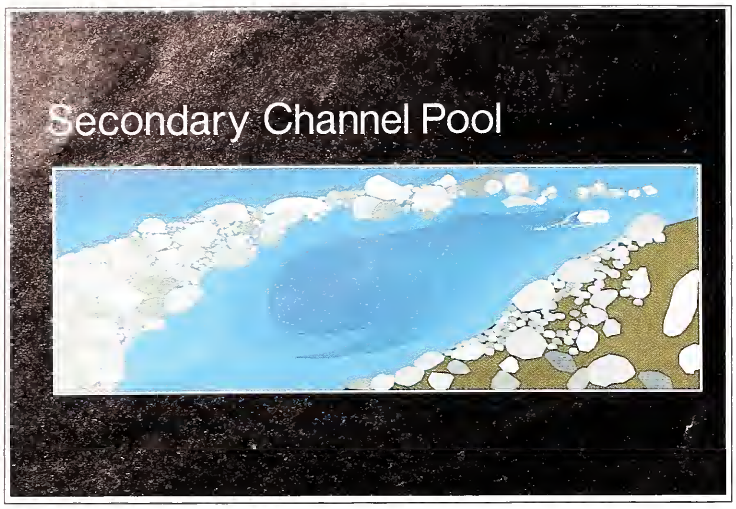
Steep reaches of moderately deep, swift, and very turbulent water. Amount of exposed substrate is relatively great. Gradient is > 4%, and substrate is boulder dominated.





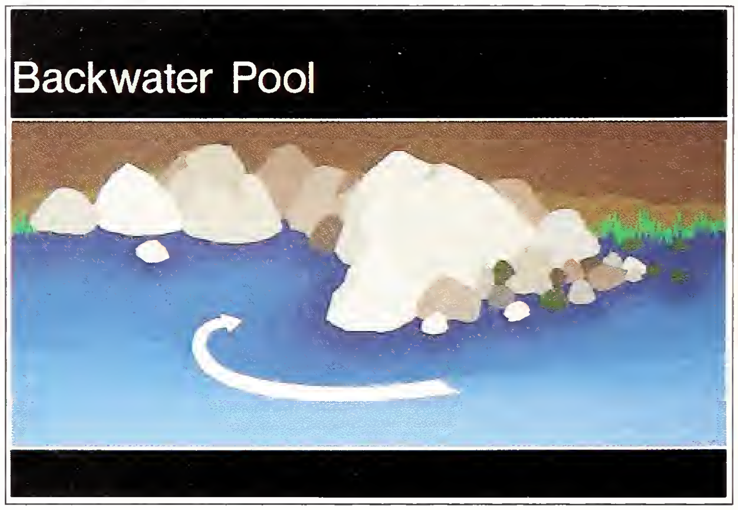
3 — Cascade "CAS"

The steepest riffle habitat, consists of alternating small waterfalls and shallow pools. Substrate is usually bedrock and boulders



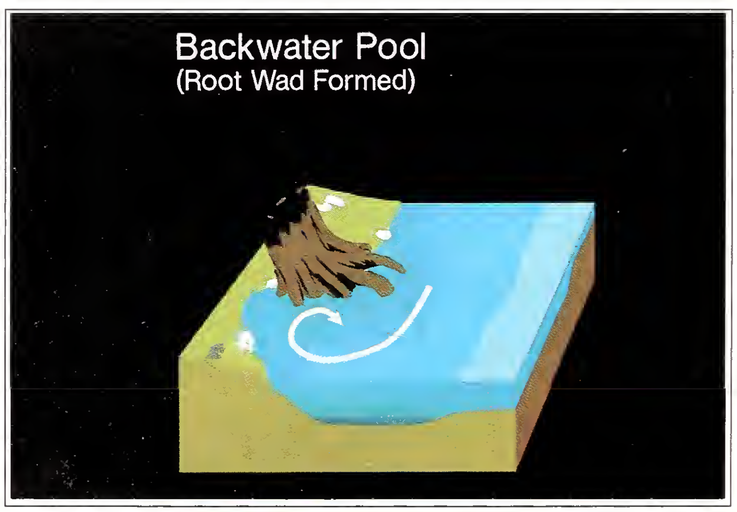
4 — Secondary Channel Pool "SCP"

Pools formed outside of the average wetted channel. During summer these pools will dry up or have very little flow. Mainly associated with gravel bars and may contain sand and silt substrates.

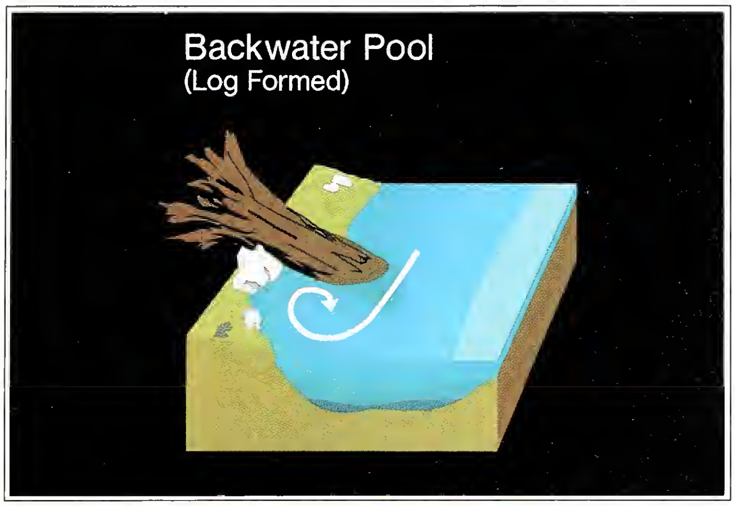


5 — Backwater Pool "BWP" Boulder Formed

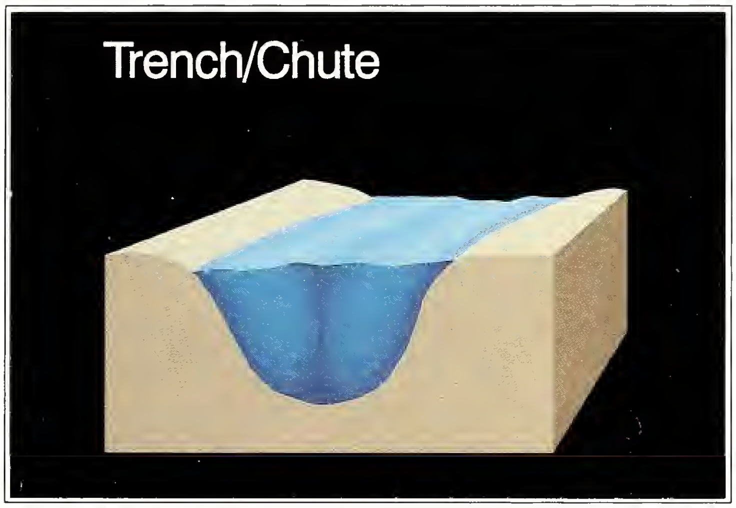
Found along channel margins and caused by eddies around obstructions such as boulders, rootwads, or woody debris. These pools are usually shallow and are dominated by fine-grain substrates. Current velocities are quite low.



6 — Backwater Pool "BWP" Root Wad Formed



7 — Backwater Pool "BWP"
Log Formed

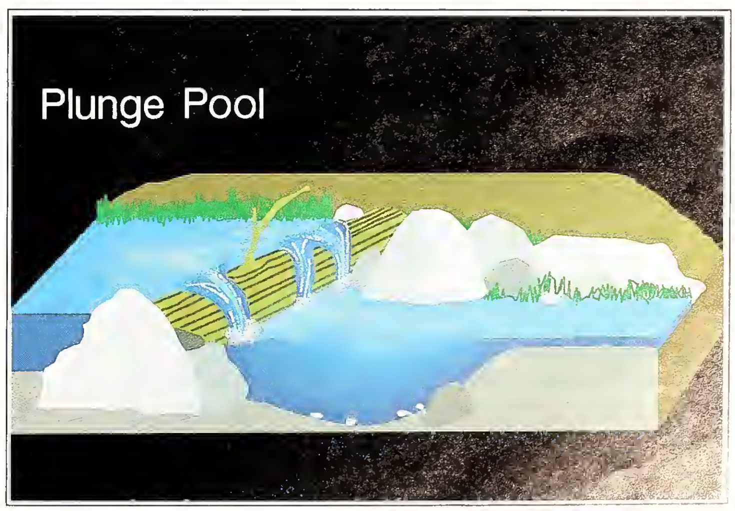


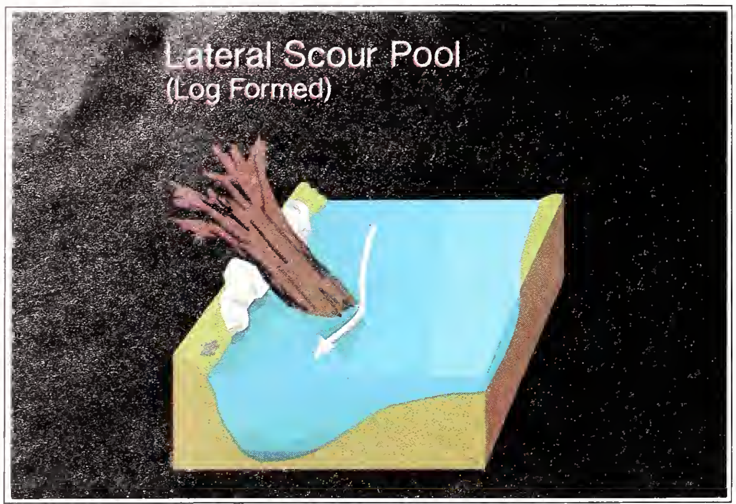
8 — Trench/Chute "TRC"

Channel cross sections typically U-shaped with bedrock or coarse grained bottom flanked by bedrock walls. Current velocities are swift and the direction of flow is uniform. May be pool-like.

9 — Plunge Pool "PLP"

Found where stream passes over a complete or nearly complete channel obstruction and drops steeply into the streambed below, scouring out a depression, often large and deep. Substrate size is highly variable.

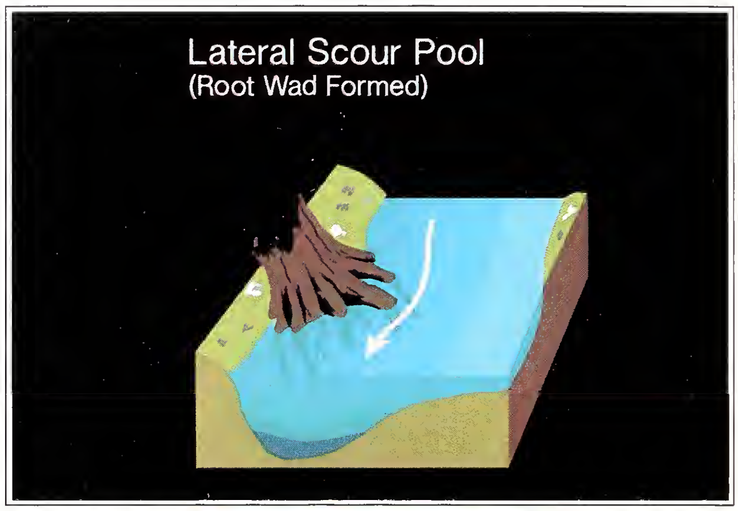




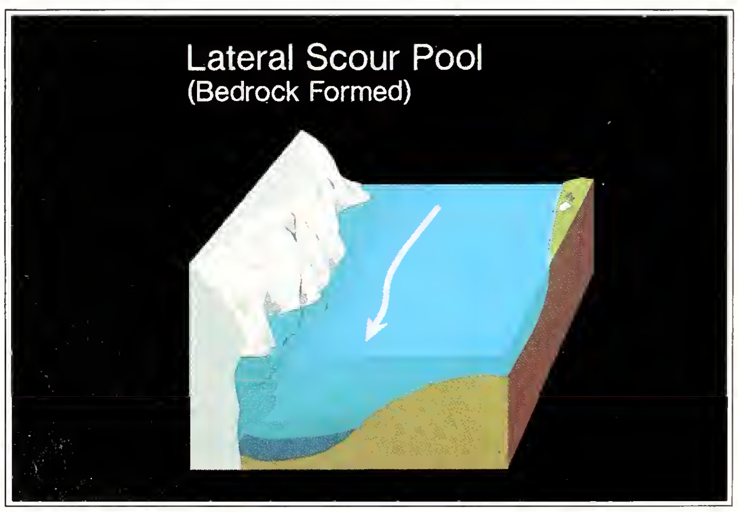
10—Lateral Scour "LSP" Log Formed

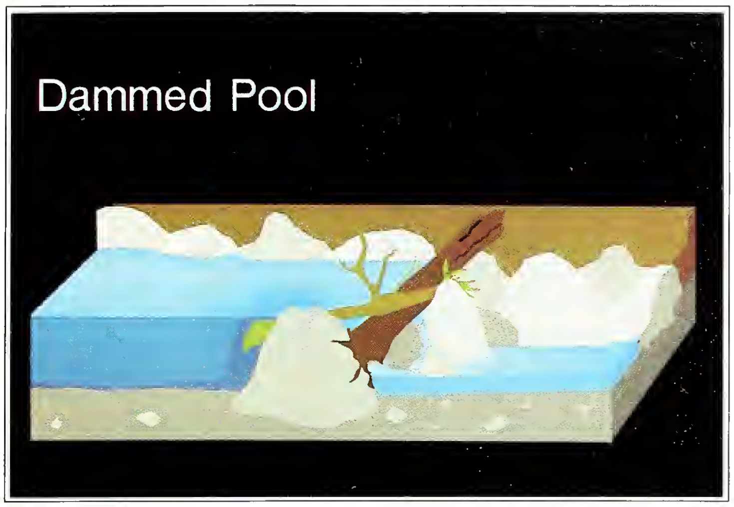
Formed by flow impinging against one stream bank or against a partial channel obstruction. The associated scour is confined to < 60% of wetted channel width. Channel obstructions include rootwads, woody debris, boulders, and bedrock.

11 — Lateral Scour Pool "LSP"
Root Wad Formed



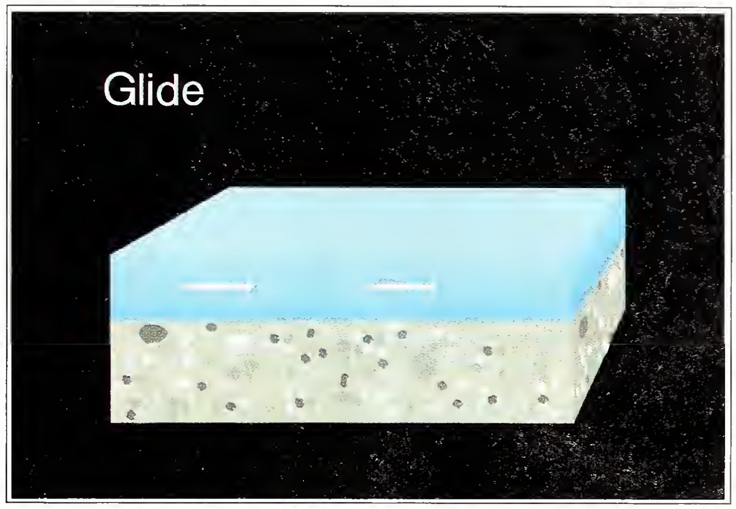
12 — Lateral Scour Pool "LSP"
Bedrock Formed





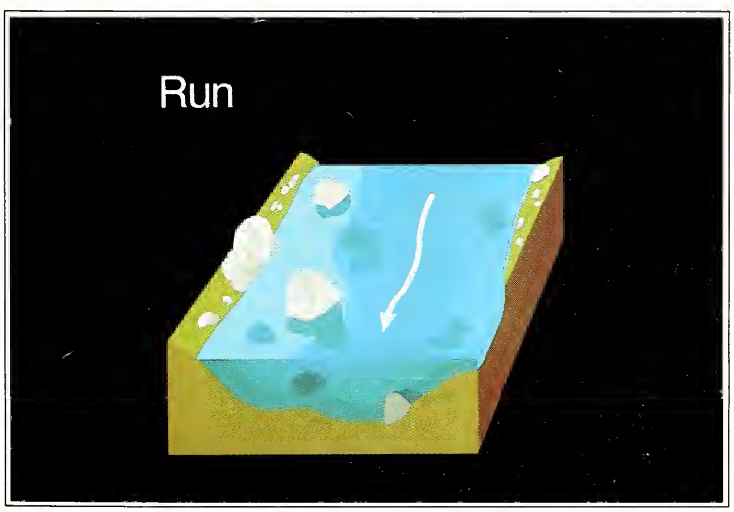
13 — Dammed Pool "DPL"

Water impounded from a complete or nearly complete channel blockage (debris jams, rock landslides or beaver dams). Substrate tends toward smaller gravels and sand.



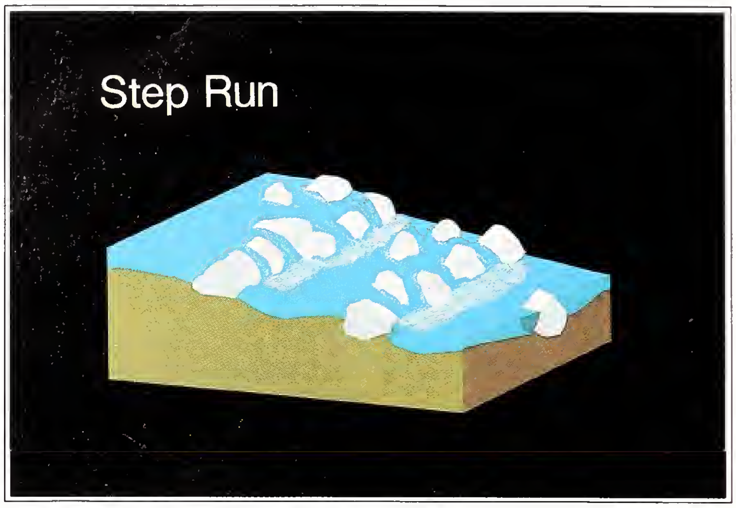
14 — Glides "GLD"

A wide shallow pool flowing smoothly and gently, with low to moderate velocities and little or no surface turbulence. Substrate usually consists of cobble, gravel and sand.



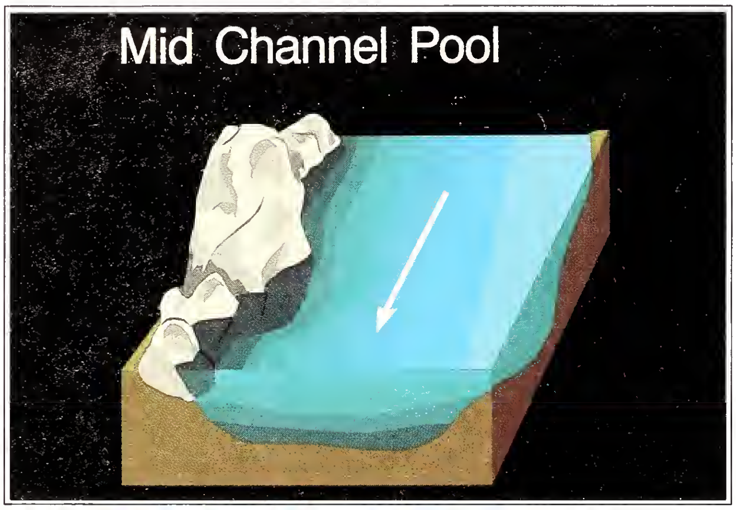
15 — Run "RUN"

Swiftly flowing reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Typical substrates are gravel, cobble and boulders.



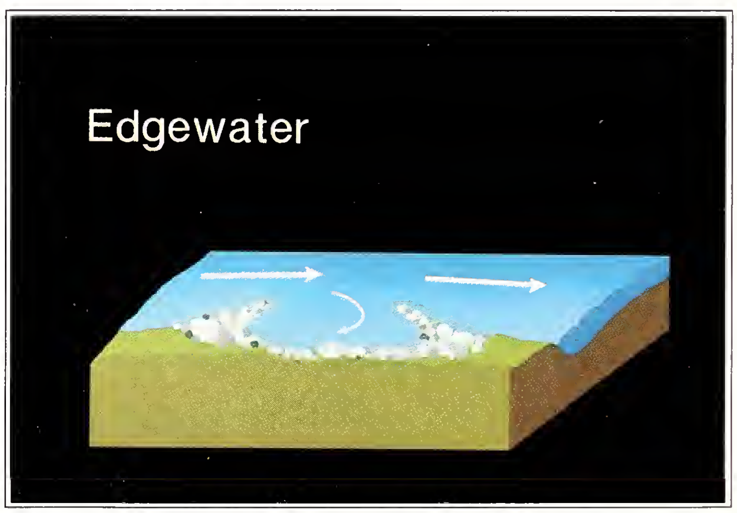
16 — Step Run "SRN"

A sequence of runs separated by short riffle steps. Substrates are usually cobble and boulder dominated.



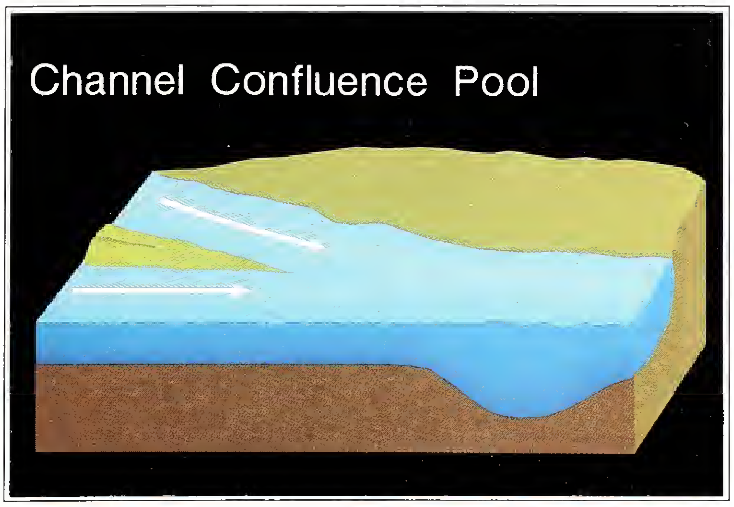
17 — Mid-Channel Pool "MCP"

Large pools formed by mid-channel scour. The scour hole encompasses more than 60% of the wetted channel. Water velocity is slow, and the substrate is highly variable.



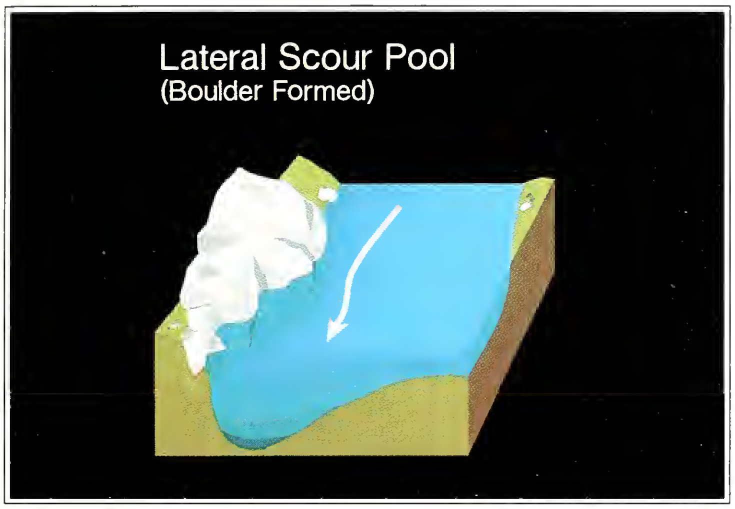
18 — Edgewater "EGW"

Quiet, shallow area found along the margins of the stream, typically associated with riffles. Water velocity is low and sometimes lacking. Substrate varies from cobbles to boulders.



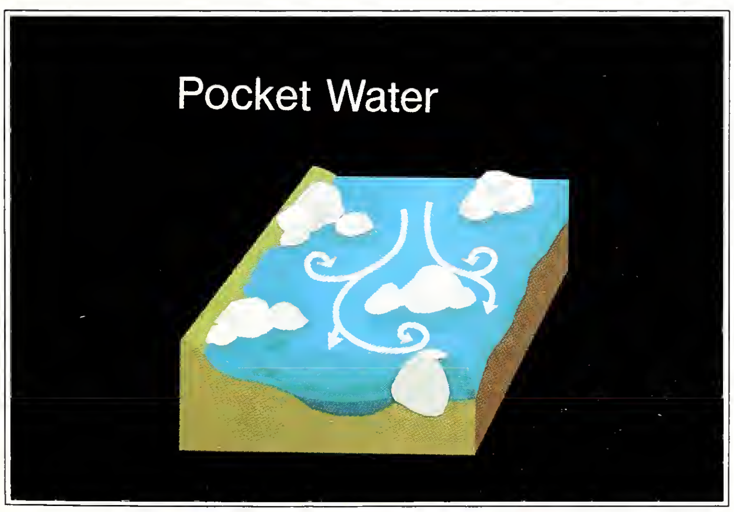
19 — Channel Confluence Pool "CCP"

Large pools formed at the confluence of two or more channels. Scour can be due to plunges, lateral obstructions or downscour at the channel intersections. Velocity and turbulence are usually greater than those in other pool types.



20 — Lateral Scour Pool "LSP"
Boulder Formed

Formed by flow impinging against boulders that create a partial channel obstruction. The associated scour is confined to < 60% of wetted channel width.

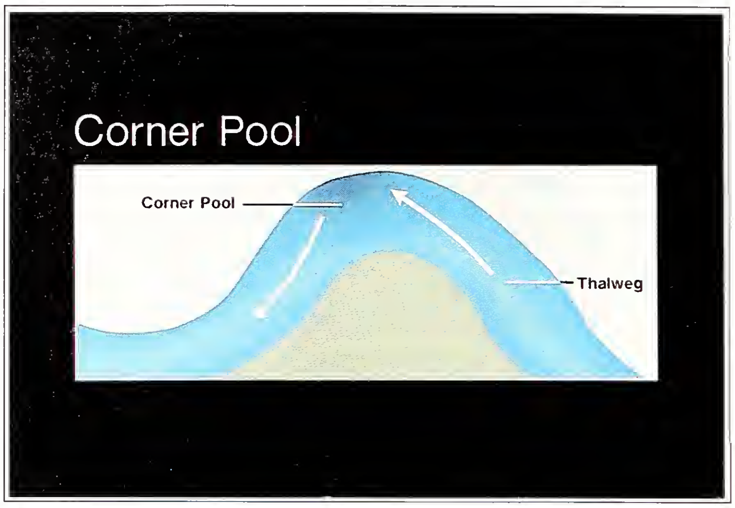


21 — Pocket Water "POW"

A section of swift flowing stream containing numerous boulders or other large obstructions which create eddies or scour holes (pockets) behind the obstructions.

22 — Corner Pool "CRP"

Lateral scour pools formed at a bend in the channel. These pools are common in lowland valley bottoms where stream banks consist of alluvium and lack hard obstructions.



broad mix of habitat types. Stratifying such a basin by gradient and confinement is therefore suggested to aid in predicting the location of certain habitat types (see Rosgen, 1985).

Procedures

Inventory Scale

In assessing habitat for a stream reach or an entire basin, the intent is to gather information that will adequately describe the area of interest. Conducting a habitat inventory can be time consuming, so work must be carried out quickly and efficiently. The level or scale of inventory to be employed is dependent on the project objectives. We have employed this system at two scales: basin level and project level. Basin level habitat classification is on the scale of a stream's naturally occurring pool-riffle-run units, where habitat unit size depends on stream size and order. As a general rule in a basin level inventory, homogeneous areas of habitat that are approximately equal or greater in length than one channel width are recognized as distinct habitat units. In comparison, project level habitat assessment operates on a scale of less than one channel width for use on reaches of intense management or study. Project level habitat typing is used to evaluate and quantify changes in habitat as the result of fish habitat restoration/enhancement projects *(figure 4)*. This information, in combination with juvenile rearing population estimates or spawning ground surveys, documents and quantifies the project's ability to provide the necessary habitats for fish production. Project level habitat size delineation depends on the nature and objectives of the particular study or work being done, which depends on the niche, size, life stage(s), etc. of the targeted species. Both levels use the same habitat types *(figure 2)*.

Data Collection

Habitat typing can be accomplished efficiently by two or three field people. Describing and measuring all 22 habitat types is very labor intensive; an average of one mile per day can be accomplished by trained surveyors. Decisions are best reached by a consensus among the team after a discussion of the facts. This approach balances out the biases inherent in each observer and insures quality in the data collected.

The basic method of habitat typing is relatively simple. Starting at the mouth of a stream and working upstream insures a known starting point. Use a measuring device (tape, rod, optical rangefinder, or hip chain) to measure mean length and width of

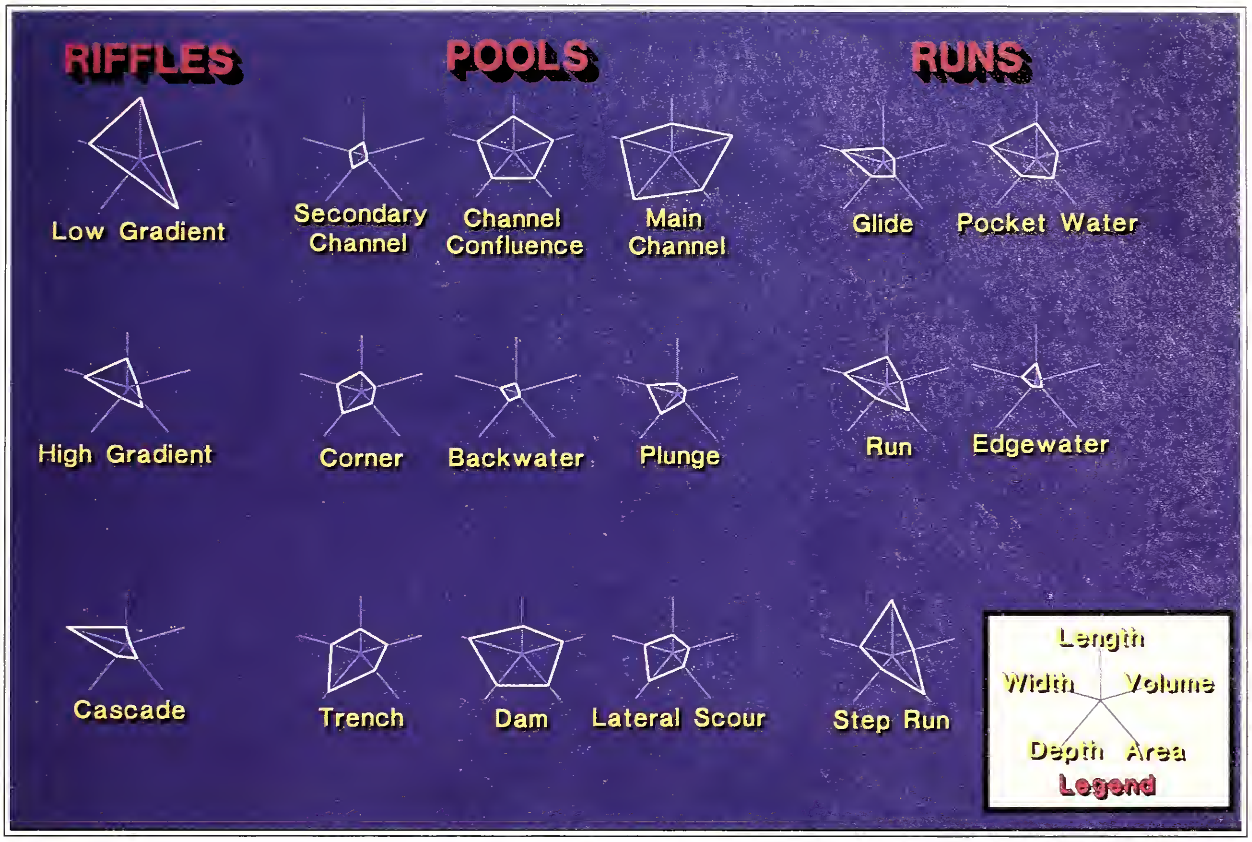


Table 1 —
Starplots of 5 main physical habitat variables. These show ratios of: mean depth, width, length, area and volume for each habitat type. Examples are from Hurdygurdy Creek, CA for Decker et al. 1984.

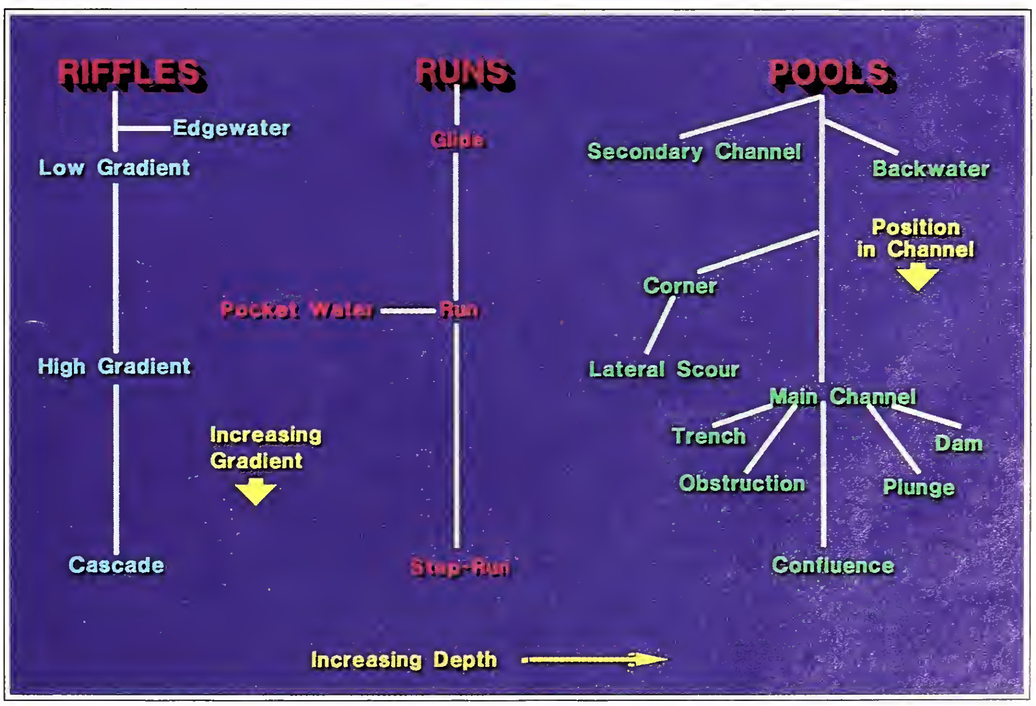


Figure 3 —
A diagram of the habitat classification system used for inventory in northern California.

each unit. Three to five width measurements are sufficient. Along each width measurement transect use a graduated leveling rod (or similar device) to take several depth measurements from bank to bank and estimate mean depth. If a significant portion (>10%) of the measured habitat includes exposed boulders and/or islands, that portion should be estimated and subtracted from calculations of area (total area - exposed area = wetted area). Other variables such as stream substrate, in-stream cover elements and abundance, canopy cover, riparian quality, etc. can be collected along with the habitat type data.

As with any classification system an occasional habitat unit may not fit distinctly into any one habitat type. In an inventory, a certain amount of subjective decision making is involved and accuracy depends heavily on a basic understanding of stream processes, a good knowledge of the classification system, and consistency (see Beschta and Platts, 1986; Lisle, 1986; and Ying, 1971).

Discussion

The basin level habitat classification and inventory procedures described will provide a channel descriptor of fish habitat availability (number, length, area, volume) and its relationship to channel features. Measurement of all 22 types gives a clear picture of the streams make-up, the type and quantity of scour forming material (logs, boulders, bed-

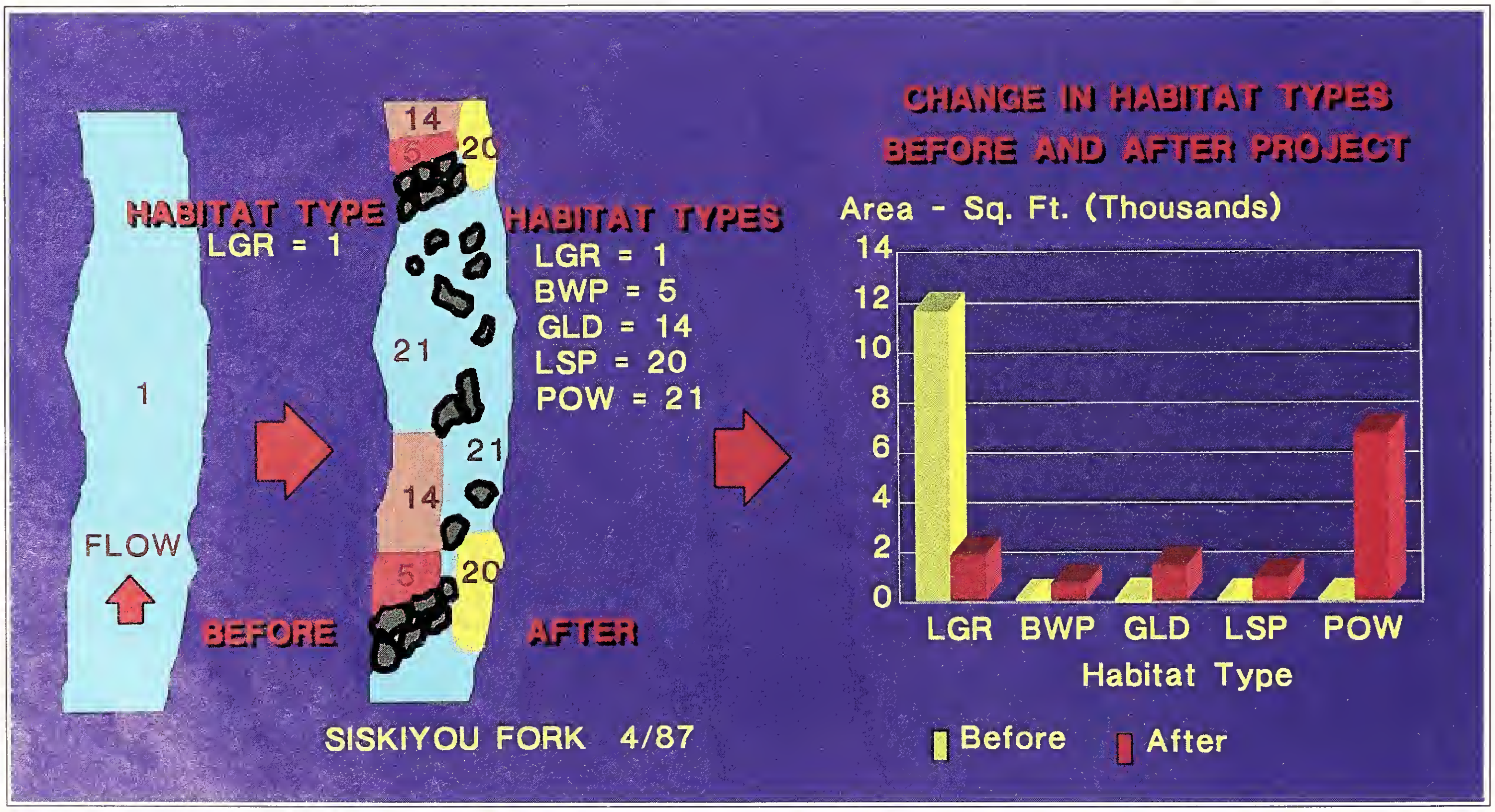


Figure 4 —
Project level habitat typing is utilized to quantify changes in specific habitat types resulting from habitat restoration/ enhancement work.

rock, etc.) that governs the mix and availability of certain habitat units. When pairing this information with population estimates per habitat unit and with fish-habitat relationship studies, the manager has the basic data for limiting factor analysis and fish production estimates *(figure 5)*.

Fish-Habitat Relationship Studies

Models are being developed and tested by the Fish Habitat Relationships (FHR) program of the USFS to aid in predicting potential fish production in a basin. Physical and biological habitat variables such as depth, velocity, substrate, cover, temperature, and food availability are being investigated in terms of their relation and relative importance to fish distribution, abundance, and community structure. The links between biological attributes such as food availability, survival, growth, age structure and physical habitat attributes such as water velocity and temperature, channel morphology, substrate particle size distribution, and habitat complexity can help managers predict the potential impacts on the fishery from watershed disturbances (logging, mining, grazing, hillslope failures and slides). The database needed to build such a predictive model must include a standardized basin level inventory of fish populations and habitat availability (Parsons, 1984). Figure 6 illustrates seasonal critical habitat needs for different fish species and life stages, serving as a basis for determining factors limiting fish production and planning habitat restoration/enhancement projects.

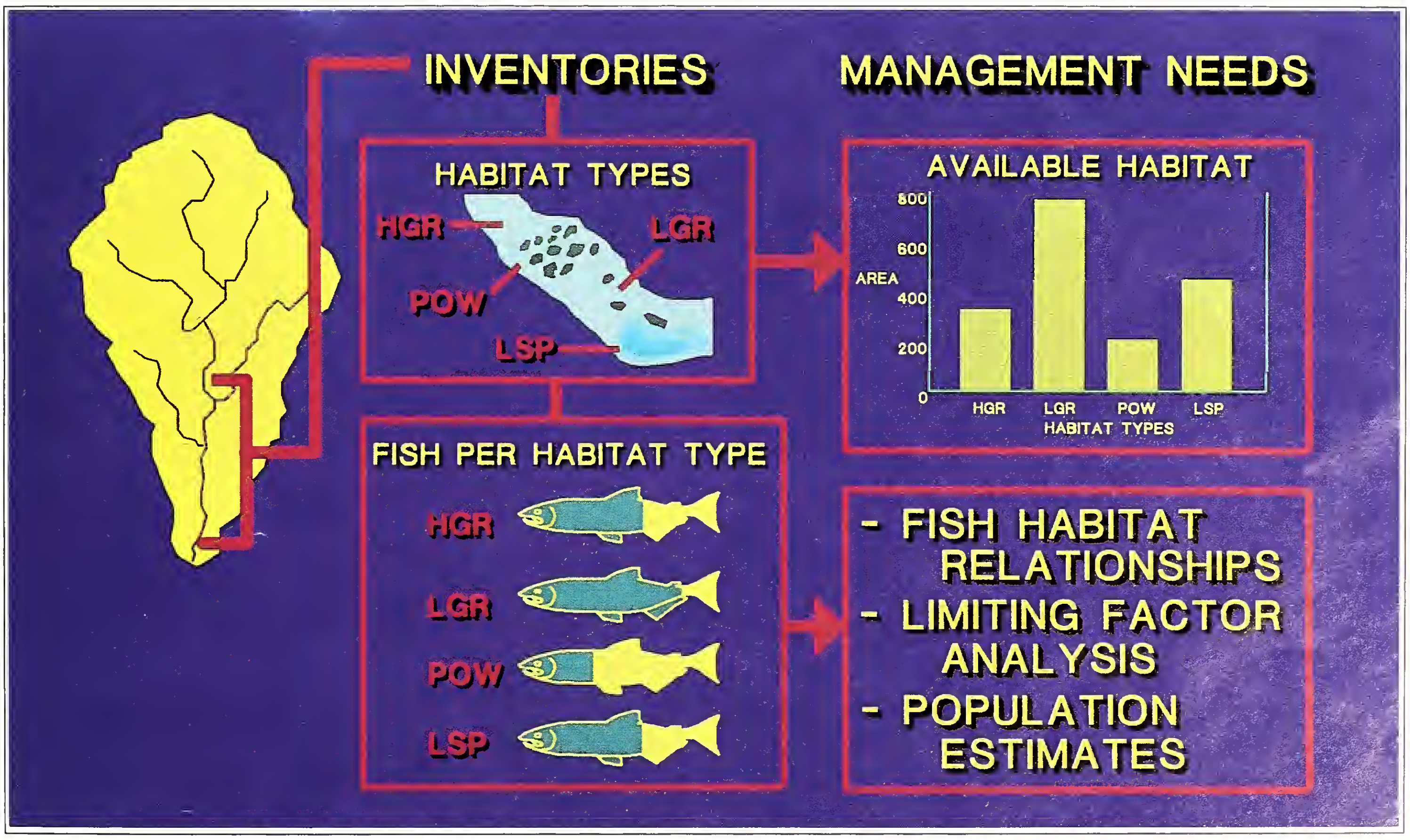


Figure 5 —
Habitat typing inventories, in conjunction with population estimates per habitat units, provide fishery managers with basic information (habitat availability, watershed fish production) for evaluating the status and potential of the watershed to produce fish.

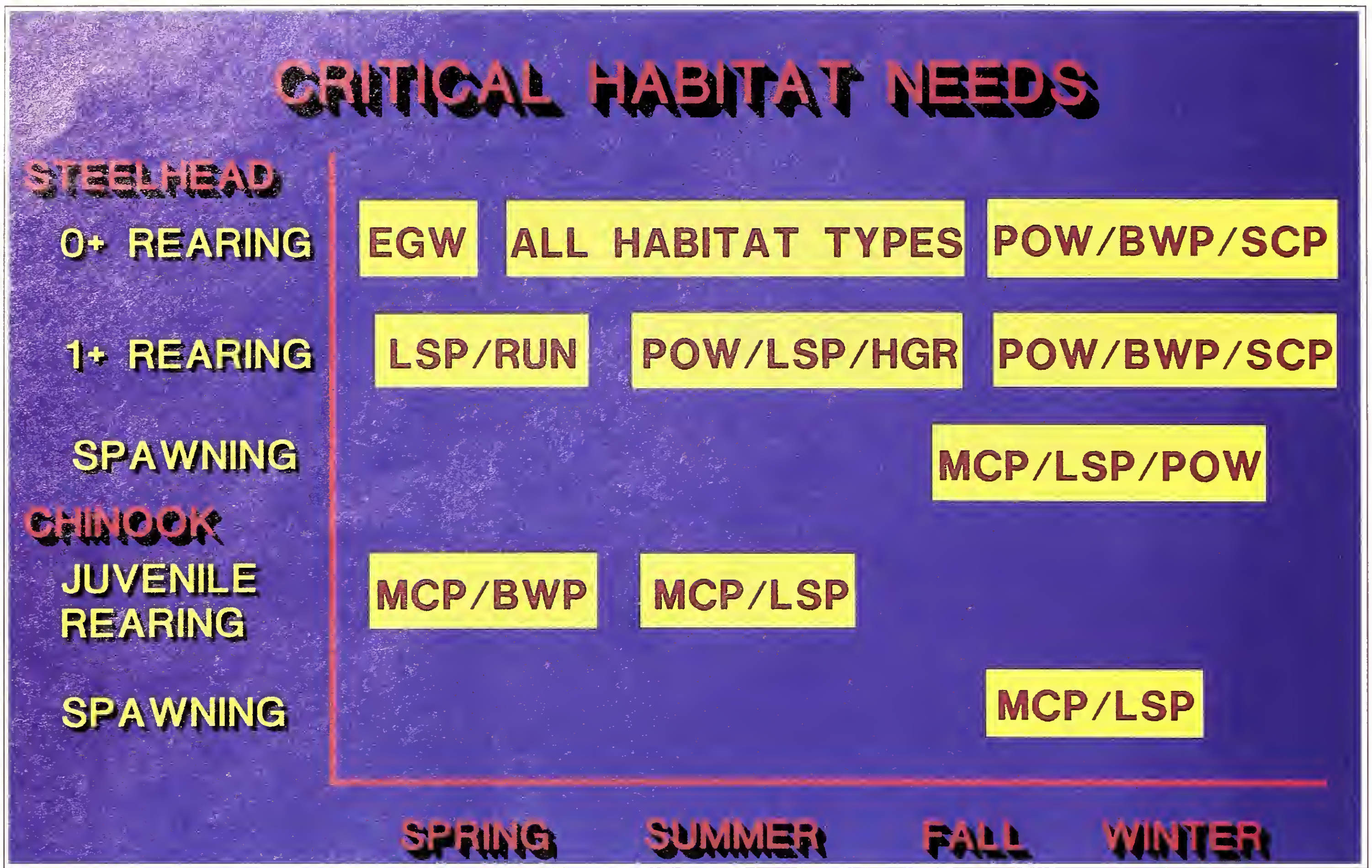


Figure 6 —
An example of seasonal habitat needs for different life stages of anadromous salmonids.

Conclusion

Habitat classification and inventories can be applied at different scales or levels and can provide basic information with which to determine the availability and importance of habitats to fish, and therefore further our understanding of fish-habitat relationships. Development of fish-habitat relationship models will increase the value of habitat information to both researchers and managers by allowing insight into the relative importance and function of physical and biological habitat parameters in the ecology of stream fishes. Aquatic habitat inventory information can serve as valuable baseline data. For example, project level habitat type information provides the habitat restoration/enhancement project designer with insight on the relationship between channel features and habitat development, and allows projects to be evaluated by quantifying the changes in habitat created by the project. Basin level information can enable researchers to develop sampling schemes based on natural habitat units.

There is a need for standardized methods in collecting stream habitat inventory information. Our fishery resources cross several management jurisdictional boundaries. Therefore, proper use and management of this resource requires responsible agencies to communicate and work together through shared information.

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Six Rivers National Forest.

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